INDEX TEST ANALYSIS OF GENERATING UNIT PERFORMANCE AT DORENA 1
3rd Index Test at 85 Ft

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Introduction

This is the 3rd in a series of reports about efficiency-testing to tune-up the 3-D Cam surface for a Kaplan hydroelectric generating unit at Dorena Dam. This report adds the third head at 85 feet Gross Head to the previously reported 69 and 48-Feet test reports. Data recorded by the powerplant datalogger is emailed to ATECo and reduced by the Index Test Box (ITB) to glean the steady-state data points needed for turbine operating efficiency analysis and optimizing its 3-D Cam data surface. The ITB detects and sorts-out the steady-state data, applies Affinity Law head corrections and computes average values with accompanying Slope and Standard Deviation "figures of merit" for every average value. These averages are analyzed to produce the optimized 3-D Cam data surface and overall blade-to-gate cam curve in a code-accepted manner.

At first blush the data seemed too sparse because 3 of the fixed-blade gate sweeps did not cross the on-cam line, but when put in context with the other two data sets a reasonable estimate of the entire cam surface can still be made.

When combined with the results of the first two index tests at 69 Ft. and 48 Ft., these results improve the extrapolation of the entire 40 to110 Foot 3-D Cam profile. The sharp change in the profile surface at 69 feet focuses interest in how the fourth test's curve behaves.
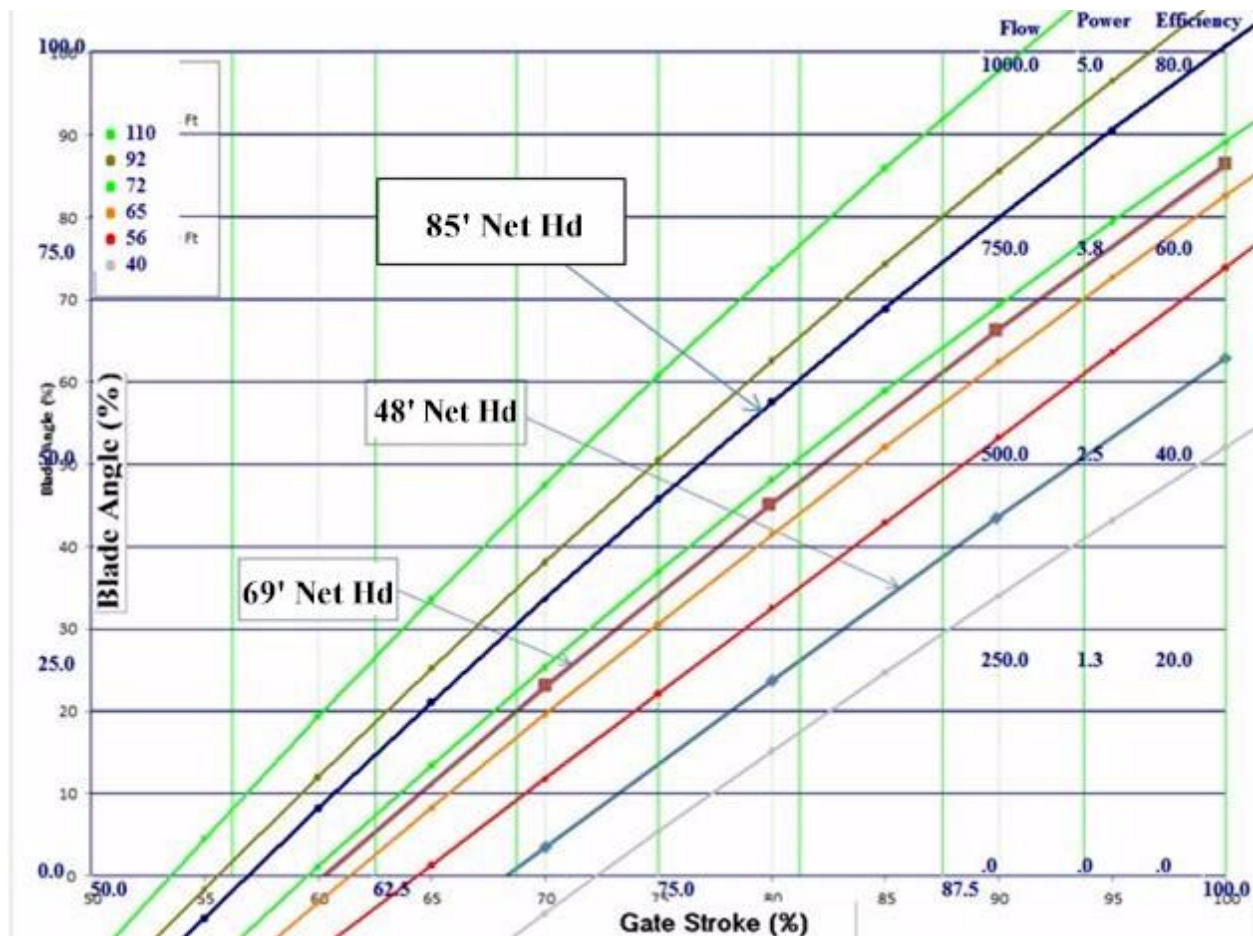
Figure 1 Best Efficiency head-lines for 48, 69 and 85-Feet Net Head as interpolated from the model-test

To show where the model-test places them the Best-Cam lines for 49, 69 and 85-feet Net Head are interpolated from the model-test data set and plotted in Figure 1.

Index Test Data
The method and procedures for collecting, reducing and analyzing the second index test were the same as those used for the first test at 69 feet gross head and the second test at 48 feet gross head.
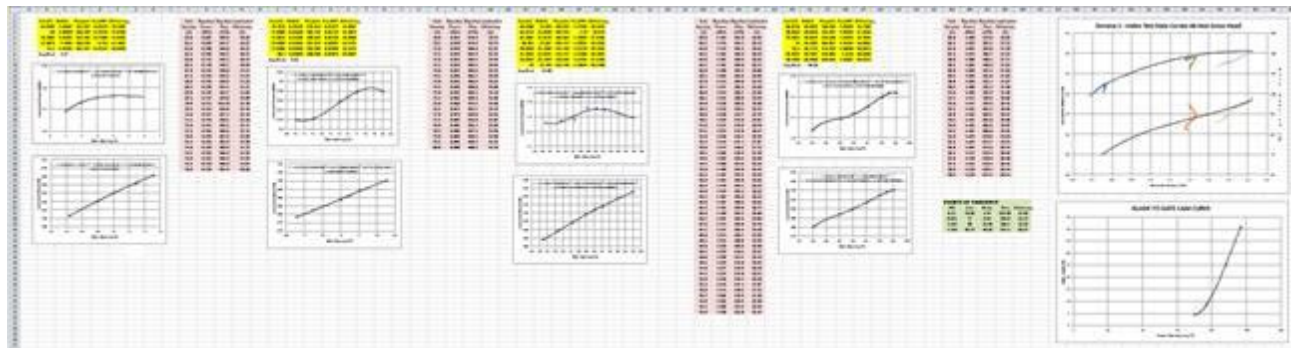
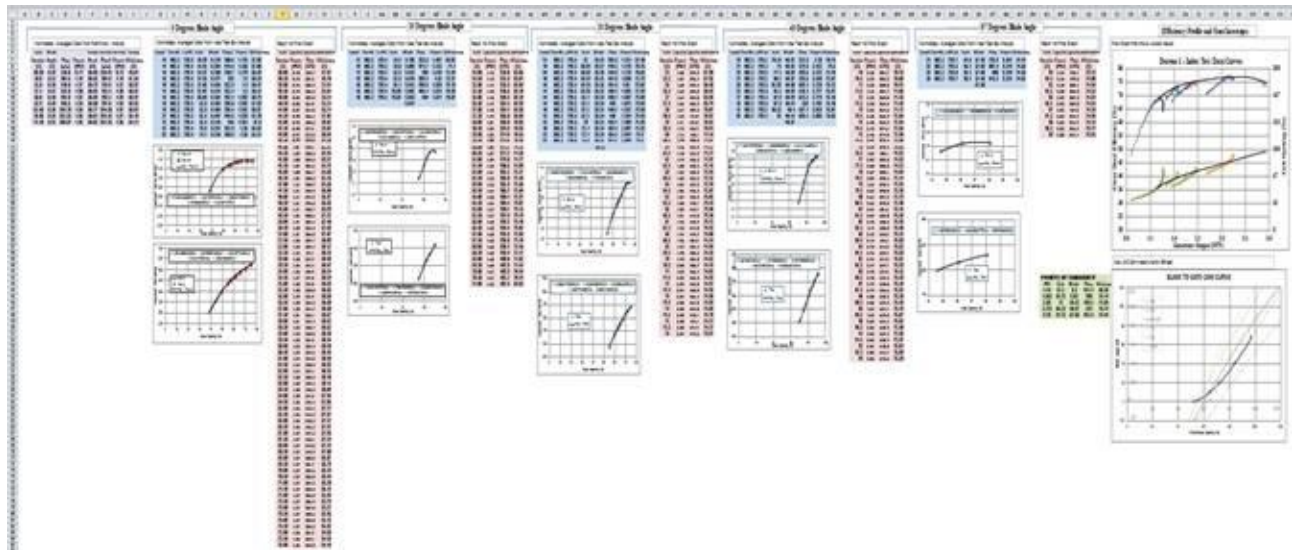**Figure 2 Index Test Analysis at 48 Feet Gross Head.**

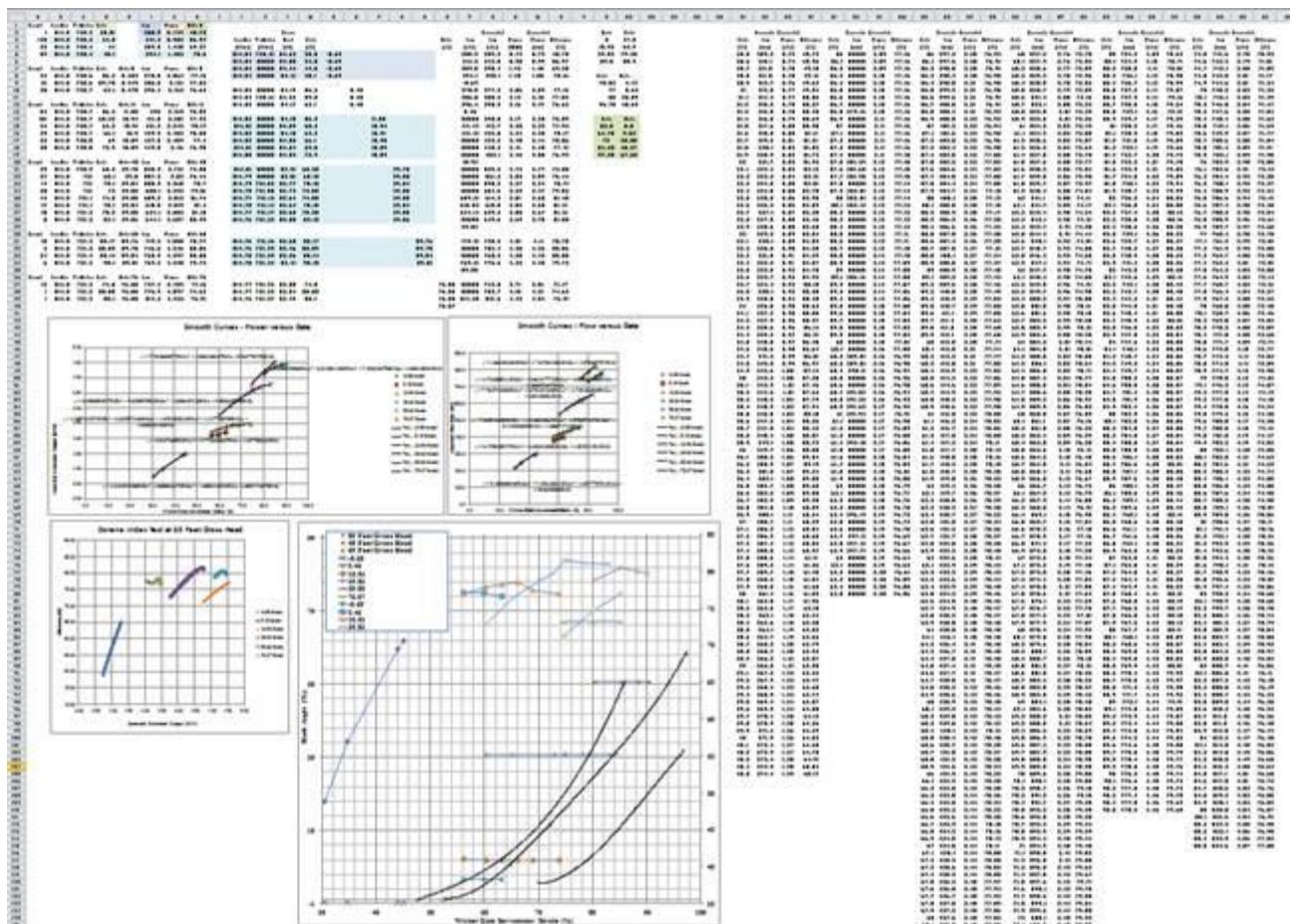**Figure 3 Index Test Analysis at 69 Feet Gross Head**

Figure 4 Index Test Analysis at 85 Feet Gross Head

3-D Cam Surface Analysis

Next the index-test best-cam lines from the three index tests at 48, 69 and 85 Feet Gross Head are merged with the model test data in Figure 1 and interpolated and extrapolated to produce the new optimized data surface seen in Figure 5.
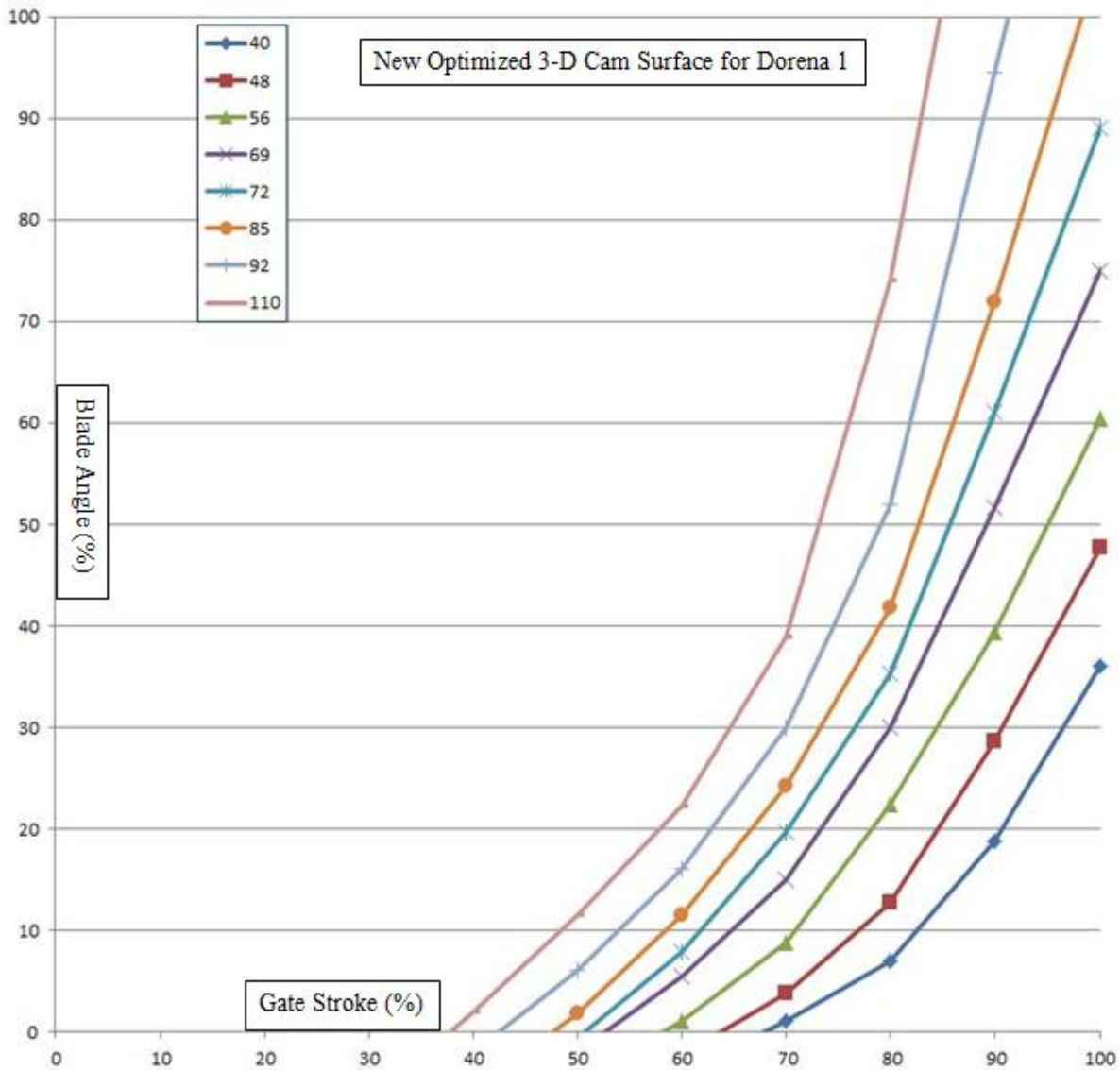
**Figure 5 New 3-D Cam surface derived from 3 field tests.**

Planning the 4rd Index Test

When the lake water level reaches the desired elevation for the final test, this estimated 3-D Cam surface will help with the planning. For example, let's consider 95 Feet Gross Head. Interpolating between the 90 and 100-feet cam-curve lines to get the new best-cam line for 95 Feet Gross Head and then "crossing the 'T'" at every 10 percent blade interval with 5 gate positions spaced at 5% intervals to show the ideal test point spread for the fourth test.
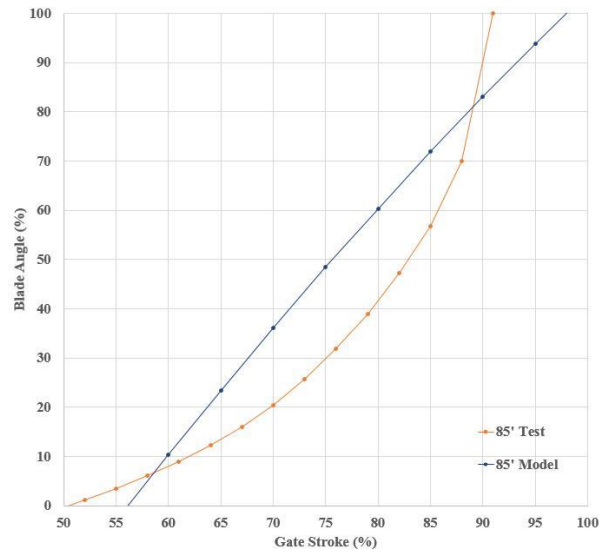
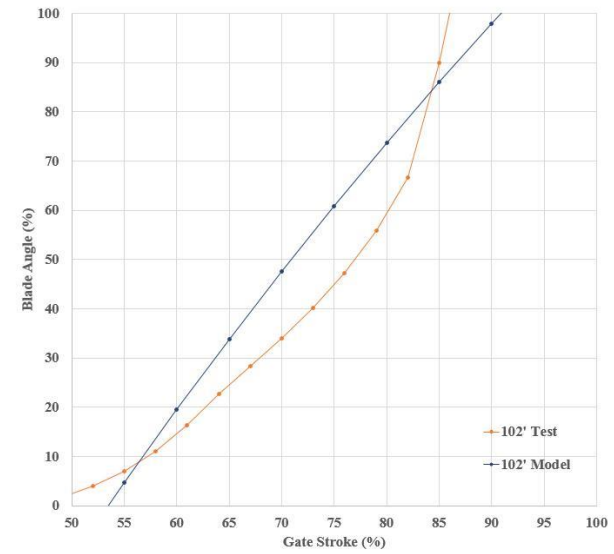**Dorena Comparison of 48' Test and 48' extrapolated Model data**
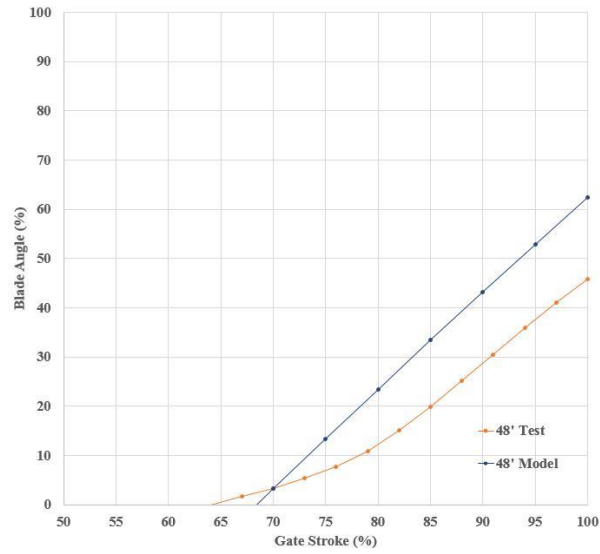
Dorena Comparison of 48' Test and 48' extrapolated Model data

Dorena Comparison of 48' Test and 48' extrapolated Model data

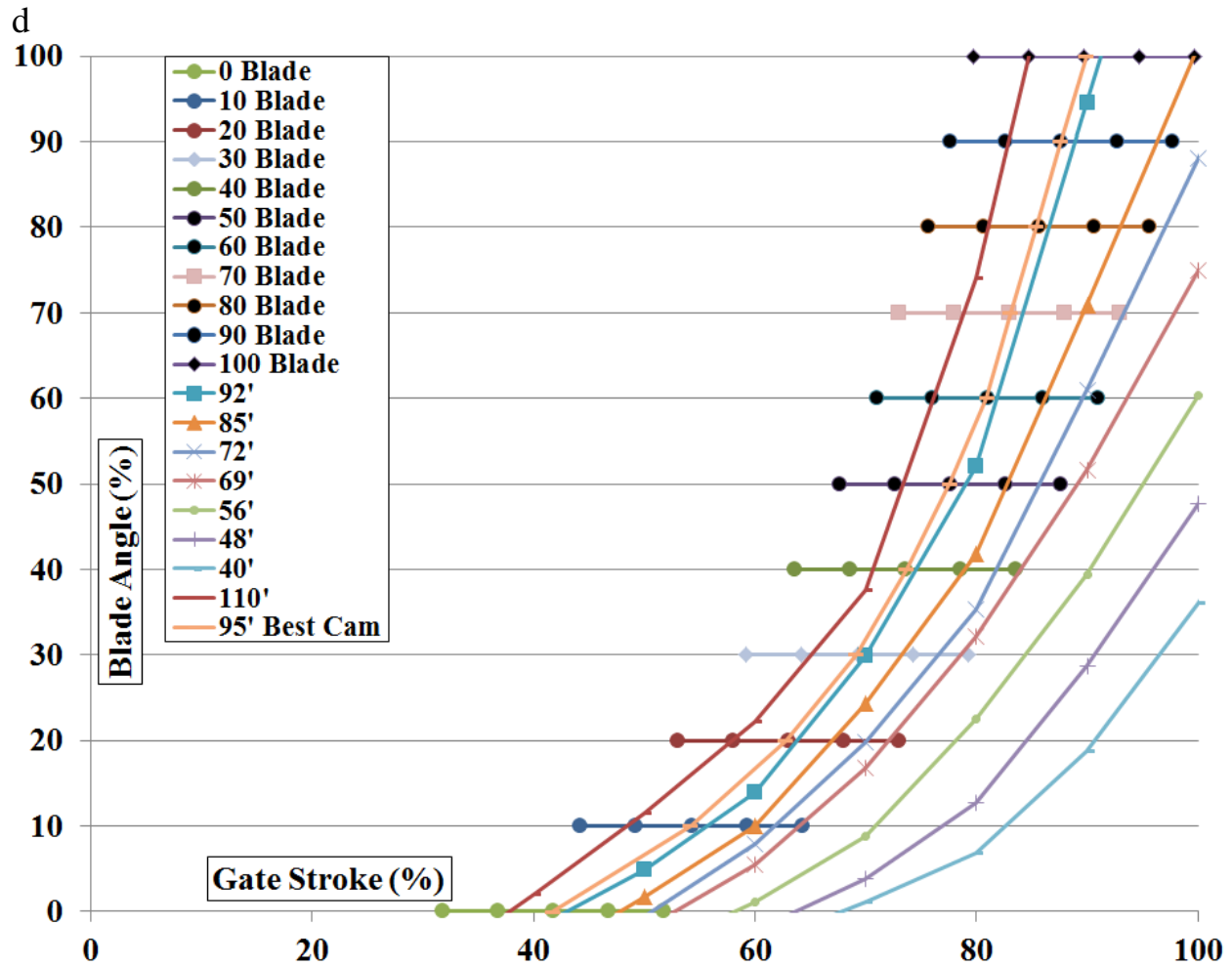**Dorena Comparison of 48' Test and 48' extrapolated Model data**

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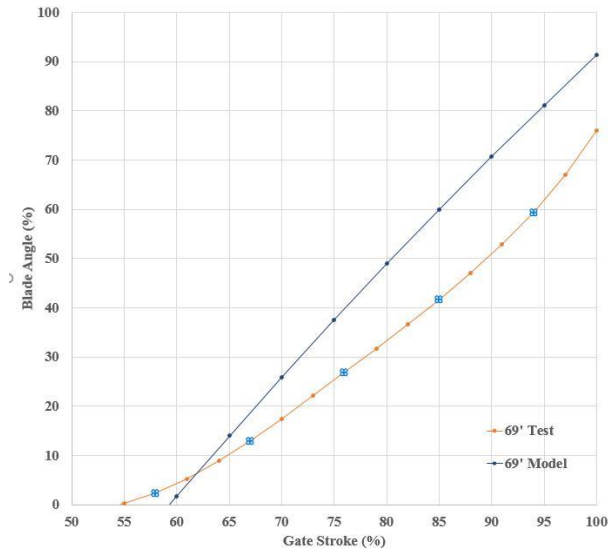
Figure 6 Proposed Test Points for 85 Feet Gross Head Index Test

Proposed index test points for 95 Feet Gross Head

Blade	Gate 1	Gate 2	Gate 3	Gate 4	Gate 5
0	31.8	36.8	41.8	46.8	51.8
10	44.25	49.25	54.25	59.25	64.25
20	52.99	57.99	62.99	67.99	72.99
30	59.22	64.22	69.22	74.22	79.22
40	63.53	68.53	73.53	78.53	83.53
50	67.6	72.6	77.6	82.6	87.6
60	70.96	75.96	80.96	85.96	90.96
70	72.99	77.99	82.99	87.99	92.99
80	75.63	80.63	85.63	90.63	95.63
90	77.66	82.66	87.66	92.66	97.66
100	79.7	84.7	89.7	94.7	99.7

If time is short, 40 and 70 percent Blade may be omitted.

Observations and Conclusion
We're ¾ of the way there now and the final result is coming into view
Using the best-cam lines from these first 3 index tests, appropriate head-gate pairs
for the remaining index test can easily be determined.
Like the first 2 tests, the data points from the 3rd index-test fall right on the
"smooth curves" in the analysis.
Reduced data scatter shows that the ITB provides superior "steady-state" data
points to conventional manual field-testing.

Sincerely,
Douglas Albright

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